

Appendix C: Evidence Table

American Radium Society® (ARS) Appropriate Use Criteria (AUC) for LDRT for Periarticular Disorders

Ref #	Reference	Study Type	Patients/Events	Study Objective (Purpose of Study)	Study Results	Study Quality
53	Morita W, Dakin SG, Snelling SJB, Carr AJ. Cytokines in tendon disease: A Systematic Review. Bone Joint Res. Dec 2017;6(12):656-664. doi:10.1302/2046-3758.612.BJR-2017-0112.R1	Systematic review	A systematic review of the literature using MEDLINE (U.S. National Library of Medicine, Bethesda, Maryland) in March 2017. Studies reporting the expression of interleukins (ILs), tumour necrosis factor alpha (TNF-α) and interferon gamma in diseased human tendon tissues, and animal models of tendon injury or exercise in comparison with healthy control tissues were included.	To examine the key cytokines responsible for driving and sustaining inflammation have not been identified.	IL-1β, IL-6, IL-10, and TNF-α are the cytokines that have been most frequently investigated. In clinical samples of tendinopathy and tendon tears, the expression of TNF-α tended not to change but IL-6 increased in tears. Healthy human tendons showed increased IL-6 expression after exercise; IL-10 remained unchanged. Animal tendon injury models showed that IL-1β, IL-6, and TNF-α tend to increase from the early phase of tendon healing. In animal exercise studies, IL-1β expression showed a tendency to increase at the early stage after exercise, but IL-10 expression remained unchanged with exercise.	4
112	Juniku N, Micke O, Seegenschmiedt MH, Muecke R. Radiotherapy for painful benign skeletal disorders : Results of a retrospective clinical quality assessment. Strahlenther Onkol. Dec 2019;195(12):1068-1073. Radiotherapie bei schmerzhaften benignen muskuloskeletalen Erkrankungen : Ergebnisse einer retrospektiven klinischen Qualitätskontrolle. doi:10.1007/s00066-019-01514-w.	Retrospective	Patients with different painful benign skeletal disorders (arthrosis and enthesopathies) were recruited for this retrospective clinical quality assessment between January 2014 and December 2015. RT was applied with a linear accelerator. Single doses of 0.5 Gy (total dose 3.0-5.0 Gy) were used. Pain was measured before and immediately after RT (early response) by a 10-point visual analogue scale (VAS). We defined a VAS score of 0-2 as a good response. Pain relief was measured during follow-up.	To evaluate the efficacy of low-dose radiotherapy (RT) for painful benign skeletal disorders.	A total of 598 evaluable patients (394 females, 204 males) with a mean age of 61.4 years (range 33-81 years) were recruited. The median VAS score was 7.0 (interquartile range [IQR] 2) before treatment and 5.0 (IQR 4) upon completion of RT (p < 0.001). A good response was achieved upon completion of RT in 83 patients (13.9%), with a median follow-up of 38 months (range 29-47 months) in 373 patients (62.4%; p < 0.001). In general, RT had a better effect on enthesopathies than on arthrosis.	3
117	Thomas TO, Deloch L, Koneru B, Shaffer R, Dove A, Kirschner AN. Low-Dose Radiation Therapy for Benign Musculoskeletal Disorders. Advances in Oncology. 2025;5(1):15–24. doi:10.1016/j.yao.2025.02.004	Review	Literature review	To discuss the biological mechanism of LDRT in treating benign musculoskeletal diseases including plantar fasciitis (PF).	RT at doses of less than 1 Gy per fraction has displayed potent anti-inflammatory effects. More recently, there has been a resurgence of the use of RT in treating benign musculoskeletal conditions primarily in the United States which has been widespread in some European countries.	4
121	Rodel F, Keilholz L, Herrmann M, Sauer R, Hildebrandt G. Radiobiological mechanisms in inflammatory diseases of low-dose radiation therapy. Int J Radiat	Preclinical	The anti-inflammatory efficiency of LD-RT was confirmed in several experimental in vitro and in vivo models.	To confirm the effectiveness of low-dose radiotherapy (LD-RT) with single	In vitro studies revealed a variety of mechanisms related to the anti-inflammatory effect, in particular the modulation of cytokine and adhesion molecule expression on activated	4

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	Biol. Jun 2007;83(6):357-66. doi:10.1080/09553000701317358			fractions below 1.0 Gy and a total dose below 12 Gy, and underlying radiobiological mechanisms	endothelial cells and leukocytes, and of nitric oxide (NO) production and oxidative burst in activated macrophages and native granulocytes.	
122	Donaubauer AJ, Mogge L, Schubert P, et al. Biological Effects of Low-Dose Radiation Therapy: From Mechanistic Aspects to Translational Approaches and Challenges. Semin Radiat Oncol. Jan 2026;36:23–38. doi:10.1016/j.semradonc.2025.10.001	Prospective nonrandomized	Within the prospective IMMO-LDRT01 trial (NCT02653079) the effects of LDRT on the peripheral blood immune status, as well as on pain and life quality of patients have been analyzed. Blood is taken before and after every serial irradiation with a single dose per fraction of 0.5Gy, as well as during follow-up appointments in order to determine a detailed longitudinal immune status by multicolor flow cytometry.	To evaluate the effects of LDR on blood immune status, as well as on pain and life quality	Results of an interim analysis of 125 patients, representing half the number of patients to be recruited. LDRT significantly improved patients' pain levels and induced distinct systemic immune modulations. While the total number of leukocytes remained unchanged in the peripheral blood, LDRT induced a slight reduction of eosinophils, basophils and plasmacytoid dendritic cells and an increase of B cells. Furthermore, activated immune cells were decreased following LDRT. Especially cells of the monocytic lineage correlated to LDRT-induced improvements of clinical symptoms, qualifying these immune cells as predictive biomarkers for therapeutic success.	2
123	*Arenas M, Gil F, Gironella M, et al. Anti-inflammatory effects of low-dose radiotherapy in an experimental model of systemic inflammation in mice. Int J Radiat Oncol Biol Phys. Oct 1 2006;66(2):560-7. doi:10.1016/j.ijrobp.2006.06.004	Preclinical	Mice were irradiated with 0.1, 0.3, 0.6 Gy, or sham radiation before lipopolysaccharide (LPS) challenge. Leukocyte-endothelial cell interactions in intestinal venules were assessed using intravital microscopy. Intercellular adhesion molecule-1 (ICAM-1) expression was determined using radiolabeled antibodies 5 h after irradiation. Production of transforming growth factor-beta1 (TGF-beta1) was measured by enzyme-linked immunosorbent assay and its in vivo functional relevance by immunoneutralization.	To determine the effects of low-dose radiotherapy (LD-RT) on the inflammatory response and to characterize the potential mechanisms underlying these effects.	Compared with vehicle treated animals, LPS induced a marked increase in leukocyte adhesion (0.13+/-0.59 vs. 5.89+/-1.03, p<0.0001) in intestinal venules. The number of adherent leukocytes was significantly reduced by the 3 doses of LD-RT tested; the highest inhibition was observed with 0.3 Gy (0.66+/-1.96, p<0.0001). LPS-induced ICAM-1 upregulation was not modified by LD-RT. Circulating levels of TGF-beta1 were significantly increased in response to LD-RT in controls and LPS challenged animals. Neutralization of TGF-beta1 partially restored LPS-induced adhesion (4.83+/-1.41, p<0.05).	4
124	Lodermann B, Wunderlich R, Frey S, et al. Low dose ionising radiation leads to a NF-kappaB dependent decreased secretion of active IL-1beta by activated macrophages with a discontinuous dose-dependency. Int J Radiat Biol. Oct 2012;88(10):727-34. doi:10.3109/09553002.2012.689464	Preclinical	Macrophages were differentiated from human THP-1 monocytes, activated with lipopolysaccharide (LPS), treated with distinct low doses of X-rays, and co-activated with monosodium urate crystals (MSU) to induce inflammasome	To investigate whether low doses of X-ray treatment modulate the inflammatory phenotype of macrophages,	Low dose X-rays led to decreased secretion of active IL-1β in a manner discontinuous with dose which was most pronounced after 0.5 or 0.7 Gy. Passive release of lactate dehydrogenase (LDH) was not influenced by X-rays. The decreased secretion of IL-1β correlated with reduced translocation of RelA, being part of the nuclear	4

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			activation. Secretion of IL-1 β was analysed by an enzyme-linked immunosorbent assay (ELISA) and Western blot. Furthermore, we analysed the intracellular amounts of the serine/threonine protein kinase B (named: Akt), mitogen-activated protein kinase p38 (p38), the v-rel reticuloendotheliosis viral oncogene homolog A (RelA), and pro- and cleaved IL-1 β .	especially the secretion of Interleukin-1beta (IL-1 β).	factor kappa-light-chain-enhancer of activated B cells (NF- κ B) complex, into the nucleus. After 0.5 or 0.7 Gy of X-rays, the intracellular protein amounts of up (p38) and downstream molecules (Akt) of NF- κ B were reduced in activated macrophages, as were the pro- and cleaved forms of IL-1 β .	
129	Micke O, Ugrak E, Bartmann S, et al. Radiotherapy for calcaneodynia, achillodynia, painful gonarthrosis, bursitis trochanterica, and painful shoulder syndrome - Early and late results of a prospective clinical quality assessment. Radiat Oncol. Apr 19 2018;13(1):71. doi:10.1186/s13014-018-1025-y	Prospective nonrandomized	Between October 2011 and October 2013, patients with calcaneodynia, achillodynia, painful gonarthrosis, painful bursitis trochanterica, and painful shoulder syndrome were recruited for this prospective clinical quality assessment. Single doses of 0.5-1.0 Gy and a total dose of 6.0 Gy per series were used. Pain was measured before and directly after RT (early response) with a visual analogue scale (VAS). Additionally, pain relief was measured with the four-scale pain score according to "von Pannewitz" (VPS) immediately at the end of RT and during follow-up. Within this context we defined a good response as complete pain relief and markedly improved.	To evaluate the short-term and long-term efficacy of low dose radiotherapy (RT) for calcaneodynia, achillodynia, painful gonarthrosis, painful bursitis trochanterica, and painful shoulder syndrome.	703 evaluable patients (461 female, 242 male) with a mean age of 63.2 years (28-96) were recruited for this prospective clinical quality assessment. In 254 patients RT was performed with the linear accelerator, 449 patients received orthovoltage radiotherapy. After a median follow-up of 33 months (3-60) 437 patients could be reached for evaluation of follow up results. The mean VAS value before treatment was 6.63 (1.9-10) and immediately on completion of RT 4.51 (0-10) (p < 0,001). Concerning the VPS immediately on completion of RT, a good response could be achieved in 264/703 patients (37.6%), and with the follow up in 255/437 patients (58.4%) (p < 0.001). Only in patients with gonarthrosis we could not observe a significantly improved long-term success in comparison to the results immediately after RT (30.2% versus 29.9%).	2
130	Seegenschmiedt MH, Micke O, Muecke R, German Cooperative Group on Radiotherapy for Non-malignant D. Radiotherapy for non-malignant disorders: state of the art and update of the evidence-based practice guidelines. Br J Radiol. Jul 2015;88(1051):20150080. doi:10.1259/bjr.20150080	Review Guidelines	NA	To summarize most of the generally accepted indications for the application of RT for non-malignant diseases and presents the special treatment concepts. The following disease groups are	These state-of-the-art guidelines may serve as a platform for daily clinical work; they provide a new starting point for quality assessment, future clinical research, including the design of prospective clinical trials, and outcome research in the underrepresented and less appreciated field of RT for non-malignant disorders.	4

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				addressed: painful degenerative skeletal disorders, hyperproliferative disorders and symptomatic functional disorders.		
131	Abdus-Salam AA, Olabumuyi AA, Jimoh MA, Folorunso SA, Orekoya AA. The role of radiation treatment in the management of inflammatory musculoskeletal conditions: a revisit. Radiat Oncol J. Sep 2020;38(3):151-161. doi:10.3857/roj.2020.00178	Review	Extensive literature search was done on PubMed and other available databases and the findings are presented and discussed.	To evaluate the role of radiation treatment in reducing pain, eliminate or reduce the need for life-long analgesic therapy and report associated side effects.	Review of several studies including over 1000 patients, only 1 patient reported mild skin redness. No other acute or late side effects were noted.	4
133	Hautmann MG, Beyer LP, Hipp M, et al. Re-irradiation for humeral epicondylitis : Retrospective analysis of 99 elbows. Strahlenther Onkol. Mar 2020;196(3):262-269. Rebestrahlung bei Epicondylitis humeri : Retrospektive Analyse von 99 Ellenbogen. doi:10.1007/s00066-019-01493-y	Retrospective	The analysis was performed on patients from three German radiotherapy institutions and included 99 re-irradiated elbows. Pain was documented with the numeric rating scale (NRS). Evaluation of the NRS was done before and directly after each radiation therapy as well as for the follow-up of 24 months. The median age of the patients was 51 years with 48.8% male and 51.2% female patients. Repeated radiation was indicated because the initial radiotherapy resulted in 39.7% of no response, in 41.0% of partial response and in 19.3% of recurrent pain.	To evaluate repeated radiation treatment and to identify those patients who will benefit.	A significant response to re-irradiation was found. For the whole sample the median pain score was 6 before re-irradiation, 3 after 6 weeks, 2 after 12 months and 1 after 24 months. The percentage of patients being free of pain or with very little pain was 50.9% 24 months after re-irradiation. All subgroups, notably those with no response, partial response and recurrent pain had a significant reduction of pain.	3
135	Rudat V, Tontcheva N, Kutz G, Orovwighose TO, Gebhardt E. Long-term effect and prognostic factors of a low-dose radiotherapy of painful plantar calcaneal spurs : A retrospective unicenter study. Strahlenther Onkol. Oct 2021;197(10):876–884. doi:10.1007/s00066-020-01741-6	Retrospective	In this retrospective unicenter study, electronic patient files of patients with painful plantar calcaneal spurs treated with low-dose radiotherapy between July 2009 and February 2020 were reviewed. The low-dose radiotherapy consisted of a total dose of 3.0 Gy given with a	To estimate the long-term effect of low-dose radiotherapy of painful plantar calcaneal spurs, and to verify possible prognostic factors.	Altogether, 864 heels of 666 patients were reviewed. The probability of an insufficient pain control 10 years after low-dose radiotherapy was 45.9% (95% confidence interval 39.4-52.4%) in the subset of patients with a minimum follow-up of 3 months (582 heels of 467 patients). Patients with an unsatisfactory pain reduction 3 months after low-dose radiotherapy were offered a re-irradiation. Forty percent of the patients who	3

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			fraction dose of 0.5 Gy three times a week. The pain reduction was estimated using a patient questionnaire with a visual analogue scale. Kaplan-Meier statistics and Cox regression analysis were used for the statistical analysis.		received a re-irradiation developed good pain reduction. Occurrence of an initial aggravation of pain during or within 3 months after low-dose radiotherapy ($p = 0.005$), and treatment of bilateral painful plantar calcaneal spurs ($p = 0.008$) were identified as significant unfavorable prognostic factors on univariate analysis. On multivariate analysis, the initial aggravation of pain remained as independent significant prognostic factor ($p = 0.01$). No clear radiation toxicity was observed. Low-dose radiotherapy is a safe and effective treatment option for patients with painful plantar calcaneal spurs. An initial aggravation of pain during or within 3 months after radiotherapy was identified as unfavorable prognostic factor for the treatment outcome. Re-irradiation of patients with an unsatisfactory p	
136	Micke O, Seegenschmiedt MH, German Cooperative Group on Radiotherapy for Benign D. Radiotherapy in painful heel spurs (plantar fasciitis)--results of a national patterns of care study. Int J Radiat Oncol Biol Phys. Mar 1 2004;58(3):828-43. doi:10.1016/S0360-3016(03)01620-1	Prospective nonrandomized cohort	In 2001, a patterns of care study was conducted in all German RT institutions using a standardized structured questionnaire. Patient accrual, patient number, pretreatment, pain record, treatment indications, RT technique, and target volume concepts for painful HSS were assessed. In addition, the functional and subjective outcomes were evaluated.	To conduct a multicenter cohort study to analyze radiotherapy (RT) in painful heel spur syndrome (HSS).	Of the institutions, 146 (79.3%) returned the questionnaire: 10 (6.8%) reported no clinical experience with RT for HSS, and 136 (93.2%) treated 3621 patients annually, a median of 23 cases/institution. The indications for treatment were chronic or therapy refractory pain. The total dose ranged between 2.5 and 18.75 Gy (median 6), and single fractions ranged between 0.3 and 1.5 Gy (median 1). Of the responding institutions, 44.9% applied two fractions and 37.5% three fractions weekly. RT was delivered with orthovoltage units (38.2%), linear accelerators (53.7%), (60)Co units (5.1%), or other treatment units (3%). Seventy-six institutions presented their retrospective clinical evaluation in a total of 7947 patients. Pain reduction for at least 3 months was reported in 70%, and persistent pain reduction was reported in 65% of the treated patients. In 19 institutions, a second RT series was applied for inadequate pain response or early pain recurrence. No radiogenic acute or chronic side effects were observed.	2
137	Abdelmaqsoud A, Vorotniak N, Strauß D, Hentschel B. The analgesic effect of low-dose radiotherapy in treating benign musculoskeletal painful disorders using different energies: A retrospective cohort	Retrospective	Between September 2019 and January 2020, a total of 91 patients with either painful inflammatory or degenerative MSDs were treated with LDRT.	To report the results of a retrospective cohort study to determine if there is a correlation	91 patients compatible with the inclusion criteria were identified with a median of 60 years. The median duration of symptoms was 6 months. 46% of patients were males, and 54% were females. The Orthovolt group included 49% of the	3

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	study. Journal of Radiotherapy in Practice. 2023;22:e78. e78. doi:10.1017/S1460396923000067		The inclusion criteria were patients older than 40 years with either painful inflammatory disorders such as epicondylitis humeri, plantar fasciitis or degenerative osteoarticular disorders of the wrist or ankle joints. All patients were treated with a single dose of 0.5 Gy and a total dose of 6.0 Gy (2 to 3 fractions weekly). Patients were divided into two groups. Orthovolt group was treated with 200 Kv, 15 mA and 1 mm copper filtration with different tubes according to the site to treatment using direct fields. The second group included patients treated with Linac machines with opposing fields using energies between 6 and 18 MV. The pain was evaluated before and on the last day of treatment and 4-6 months later using the Numerical Rating Scale.	between the effectiveness of low-dose radiotherapy (LDRT) in treating painful inflammatory or degenerative musculoskeletal disorders (MSDs) and the applied radiotherapy energy.	patients and the Megavoltage group 51%. Most of the patients (98%) were previously treated with other methods such as local corticosteroid injection, painkillers or physiotherapy. At the end of the treatment, 60% of the patient's showed subjective pain relief and only 6% had a complete response. The follow-up conducted 4 to 6 months after the treatment showed that 65% of patients had a complete response and 8% had an improvement. The comparison between both studied groups shows that the used energy does not affect the response either at the end of the treatment or at the second control. The relationship between the aetiology and the early and late responses shows no difference in the early response but a better late response in patients suffering from inflammatory diseases with a p-value of 0.015. The response according to the treated location shows that patients with osteoarthritis of the ankle joint have a worse response in comparison to other examined joints and plantar fasciitis.	
138	Niewald M, Fleckenstein J, Naumann S, et al: Long-term results of radiotherapy for periarthritis of the shoulder: a retrospective evaluation. Radiat Oncol 14(2):34, 2007. doi.org/10.1186/1748-717X-2-34	Retrospective	In 1983–2004, 141 patients were treated, all had attended at least one follow-up examination. 19% had had pain for several weeks, 66% for months and 14% for years. Shoulder motility was impaired in 137/140 patients. Nearly all patients had taken oral analgesics, 81% had undergone physiotherapy, five patients had been operated on, and six had been irradiated. Radiotherapy was applied using regular anterior-posterior opposing portals and Co-60 gamma rays or 4 MV photons. 89% of the patients received a total dose of 6 Gy (dose/fraction of 1 Gy twice weekly, the others had total	To evaluate retrospectively the results of radiotherapy for periarthritis of the shoulder	During the first follow-up examination at the end of radiotherapy 56% of the patients reported pain relief and improvement of motility. After in median 4.5 months the values were 69 and 89%, after 3.9 years 73% and 73%, respectively. There were virtually no side effects. In the questionnaires, 69% of the patients reported pain relief directly after radiotherapy, 31% up to 12 weeks after radiotherapy. 56% of the patients stated that pain relief had lasted for "years", in further 12% at least for "months".	3

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			doses ranging from 4 to 8 Gy. The patients and the referring doctors were given written questionnaires in order to obtain long-term results. The mean duration of follow-up was 6.9 years [0–20 years].			
139	Hautmann MG, Beyer LP, Sub C, et al: Radiotherapy of epicondylitis humeri: analysis of 138 elbows treated with a linear accelerator. Strahlenther Onkol 195(4):343-351, 2019. doi.org/10.1007/s00066-018-1397-9	Retrospective	The analysis was performed on patients of 2 German radiotherapy institutions and included 138 irradiated elbows. Pain was documented with the numeric rating scale (NRS). Evaluation of the NRS was done before and directly after each radiation therapy course as well as for the follow-up of 24 months. The median age of the patients was 49 years with 48.4% male and 51.6% female. In all, 81.0% were suffering from from epicondylitis humeri radialis while 16.7% were treated because of epicondylitis humeri ulnaris. In 65.4% the dominant arm was treated.	To analyze the results of radiotherapy with a linear accelerator for epicondylitis humeri.	A significant response to radiotherapy could be found. For the whole sample the median pain was 7 on the NRS before radiotherapy, 4 after 6 weeks and 0 after 12 and 24 months. The percentage of patients with 0 or 1 on the NRS was 64.6% 12 months after radiotherapy. All subgroups, notably those with epicondylitis humeri radialis and epicondylitis humeri ulnaris had a significant reduction of pain.	3
140	Kaltenborn A, Carl UM, Hinsche T, Nitsche M, Hermann RM. Low-dose external beam radiotherapy for greater trochanteric pain syndrome : Target volume definition and treatment outcome. Strahlenther Onkol. Apr 2017;193(4):260-268. Niedrig dosierte Reizbestrahlung beim Trochanter-major-Schmerzsyndrom : Zielvolumendefinition und Therapieergebnisse. doi:10.1007/s00066-016-1071-z	Retrospective	In all, 60 patients (74 hips) received LD-EBRT (6 × 0.5 Gy in 29 hips, 6 × 1 Gy in 45). The endpoint was the patient's reported subjective response to treatment. The influence of different patient and treatment characteristics on treatment outcome was investigated.	To report results of Low-dose external beam radiotherapy (ED-EBRT) used in the therapy of refractory greater trochanteric pain syndrome (GTPS).	At the end of LD-EBRT, 69% reported partial remission, 4% complete remission, no change 28%. A total of 3 months later (n = 52 hips), the results were 37, 33, and 30% and 18 months after LD-EBRT (n = 47) 21, 51, and 28%. In univariate analysis "inclusion of the total femoral head into the PTV" and "night pain before LD-EBRT" were correlated with symptom remission at the end of LD-EBRT, while "initial increase in pain during LD-EBRT" was significantly associated with treatment failure. In multivariable modeling "initial increase in pain" was identified as a risk factor for treatment failure (p = 0.007; odds ratio [OR] 0.209; 95% confidence interval [CI] 0.048-0.957), while "night pain" was an independent factor for remission (p = 0.038; OR 3.484; 95% CI 1.004-12.6). Three months after LD-EBRT "night pain" and "inclusion of the complete femoral neck	3

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					circumference into the PTV" were predictive for remission.	
141	Micke O, Seegenschmiedt MH, Adamietz IA, et al. Low-Dose Radiation Therapy for Benign Painful Skeletal Disorders: The Typical Treatment for the Elderly Patient? Int J Radiat Oncol Biol Phys. Jul 15 2017;98(4):958-963. doi:10.1016/j.ijrobp.2016.12.012	Prospective nonrandomized	Between October 2011 and October 2013, patients aged ≥70 years with painful degenerative disorders of joints were recruited for a prospective trial. Single doses of 0.5 to 1.0 Gy and a total dose of 6.0 Gy per series were used. Pain was measured before and right after RT (early response) with a 10-point visual analogue scale. Additionally, pain relief was measured with the 4-point pain scale according to "von Pannewitz" immediately on completion of RT and during follow-up. We defined a good response as complete pain relief and markedly improved.	To prospectively evaluate the short-term and long-term efficacy of low-dose radiation therapy (RT) for calcaneodynia, achillodynia, painful gonarthrosis, and painful bursitis trochanterica in elderly patients aged ≥70 years.	A total of 166 evaluable patients with a mean age of 76.6 years (range, 70-90 years) with calcaneodynia (n=51), achillodynia (n=8), painful gonarthrosis (n=80), and painful bursitis trochanterica (n=27) were recruited. The mean visual analogue scale value before treatment was 6.38 and immediately upon completion of RT was 4.49 (P<.001). Concerning the von Pannewitz status immediately on completion of RT, 6 patients were free of pain, 56 were much improved, 47 reported slight improvement, and 57 experienced no change. After a median follow-up of 29 months, 109 patients could be reached for evaluation of follow-up results. Thirty-three patients were free of pain, 21 had marked improvement, 18 had some improvement, and 37 experienced no change. Therefore, a good response immediately on completion of RT could be achieved in 62 of 166 patients, and with the follow-up in 54 of 109 patients (P=.001).	2
142	Heyd R, Schopohl B, Kirchner J, Strassmann G, Bottcher HD. [Radiotherapy of epicondylopathy of the humerus]. Dtsch Med Wochenschr. Feb 28 1997;122(9):247–52. Strahlentherapie der Epicondylopathia humeri. doi:10.1055/s-2008-1047604	Prospective nonrandomized	45 elbow joints in 41 patients were radiated with a telecobalt unit in six sessions at a dose of 1.0 Gy each spread over 3 weeks. Indication for this treatment was pain in the elbow Joint at rest, on pressure and on exercise. The patients were re-assessed after a mean follow-up period of 7.5 weeks. They were graded into one of five groups on the basis of their own assessment. Pain on exercise was determined by the Thompson hand-grip, chair test, forced extension and middle-finger Stretch test.	To assess the efficacy of radiotherapy in alleviating pain at rest and on exercise in tennis elbow (humeral epicondylitis).	Satisfactory analgesia was achieved in 31 of 45 elbow joints (68.9 %). About 50 % of patients still had objectifiable pain on exercise.	2
143	Heyd R, Seegenschmiedt MH. [Epicondylopathia humeri radialis: efficacy of radiation therapy]. MMW Fortschr Med. Feb 11 2010;152(6):37–9. Epikondylopathia humeri radialis: mit	Prospective nonrandomized	45 elbow joints in 41 patients were radiated with a telecobalt unit in six sessions at a dose of 1.0 Gy each spread over 3 weeks. Indication for this treatment was pain in the elbow joint at rest, on	To assess the efficacy of radiotherapy in alleviating pain at rest and on exercise in tennis elbow	Satisfactory analgesia was achieved in 31 of 45 elbow joints (68.9%). About 50% of patients still had objectifiable pain on exercise.	2

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	Orthovolt und Photonen gegen den Tennisellenbogen.		pressure and on exercise. The patients were re-assessed after a mean follow-up period of 7.5 weeks. They were graded into one of five groups on the basis of their own assessment. Pain on exercise was determined by the Thompson hand-grip, chair test, forced extension and middle-finger stretch test.	(humeral epicondylitis).		
144	Seegenschmiedt MH, Keilholz L, Martus P, Kuhr M, Wichmann G, Sauer R. [Epicondylopathia humeri. The indication for, technic and clinical results of radiotherapy]. Strahlenther Onkol. Apr 1997;173(4):208–18. Epicondylopathia humeri. Indikation, Technik, klinische Ergebnisse der Radiotherapie. doi:10.1007/BF03039290	Prospective nonrandomized	From 1986 to 1991, 104 patients with refractory epicondylopathia humeri were irradiated. 85 patients or 93 elbows (due to double-sided symptoms) were documented in long-term follow-up according to objective criteria. All patients had received intensive therapy. Pain symptoms were quantified in "categories" and "grades" prior to and 6 weeks after radiotherapy and at last follow-up. In addition, the elbow score of Morrey et al. [36] was used for long-term evaluation. The onset of pain symptoms was acute in 41 and chronic in 52 cases. The mean symptom duration prior to radiotherapy was 16 months. Pain was mostly triggered off during professional (46) or sportive activities (23) or spontaneously (11). Fifty-one patients were severely disabled in professional or sportive activities. The involved elbow(s) received 2 radiotherapy series of 6 x 1 Gy (total 12 Gy) with 3 fractions per week; the second radiotherapy series was started 6 weeks after the first series. Mean follow-up was 4 +/- 2 (1 to 8) years.	The efficacy of radiotherapy for degenerative-inflammatory disorders is well known, but so far long-term observations and reliable assessment of symptoms according to objective criteria and scores for validation are still missing.	Forty-three patients (50 elbows) achieved "complete pain relief (CR)" in all pain categories: 59% elbows with pain at strain had "complete pain relief", 79% with pain at night, 84% with permanent pain, 80% with pain at rest and 81% with pain at initiation or morning stiffness. Nineteen elbows gained "major pain relief (PR)", i.e. had minor symptoms (maximum grade 1) in all categories. Thus, a total of 69 (74%) elbows responded to radiotherapy. Seventeen patients (19 elbows) were operated because of persistent symptoms or dissatisfaction in long-term follow-up; 7 of those became completely free of symptoms. The Morrey-Score improved by a mean of 18 points from 78 prior to radiotherapy to 96 points at last follow-up. According to the Morrey-Score only 2 patients became worse in long-term follow-up. Two parameters indicated a negative prognosis in multivariate analysis: long symptom duration prior to radiotherapy and immobilisation with plaster (p < 0.05).	2

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145	Rogers S, Eberle B, Vogt DR, et al. Prospective Evaluation of Changes in Pain Levels, Quality of Life and Functionality After Low Dose Radiotherapy for Epicondylitis, Plantar Fasciitis, and Finger Osteoarthritis. <i>Front Med (Lausanne)</i> . 2020;7:195. doi:10.3389/fmed.2020.00195	Prospective nonrandomized	Patients over 40 years old with epicondylitis, plantar fasciitis, and finger osteoarthritis were had pain following at least 6 months of conservative therapy. Patients received 0.5 Gy LDRT twice weekly for 4 weeks repeated once after 8 weeks in patients who failed to achieve complete pain relief. Patients assessed their pain according to the visual analog scale. Handgrip strength was measured with an isometric dynamometer and the fast self-paced walking test was used in patients with plantar fasciitis. QoL was evaluated according to the EQ-5D and HAQ-DI questionnaires.	To evaluate changes in pain, quality of life (QoL) and function after LDRT for epicondylitis, plantar fasciitis, and finger osteoarthritis.	Outcomes for 157 patients (204 sites) were documented at 2, 6, and 12 months after last LDRT. Pain reduction at rest ($p < 0.001$), during activity ($p < 0.001$) and increase in handgrip strength (extension $p < 0.001$, flexion $p = 0.002$) were highly significant for patients with lateral epicondylitis. Patients with medial epicondylitis reported pain relief at rest ($p = 0.041$) and during activity ($p = 0.041$) and significant increase in handgrip strength ($p = 0.022$). Patients with plantar fasciitis reported pain reduction at rest ($p < 0.001$), during activity ($p < 0.001$) and faster walking times ($p < 0.001$). A trend toward improved QoL was observed. Patients with finger osteoarthritis reported significant pain relief during activity ($p < 0.001$) and a gain in handgrip strength ($p = 0.004$), with a trend to both pain relief at rest ($p = 0.056$) and stronger pinch grip ($p = 0.099$).	2
146	Biete A, Valduvicio I, Arenas M, Holub K. Low-Dose Radiotherapy as an Effective Treatment of Trochanteric Bursitis in Elderly Patients. <i>Ann Radiat Ther Oncol</i> . 2017;1(1):1003.	Prospective nonrandomized	We evaluated a total of 155 patients (90.3% women, mean age 69 years). Most patients ($n = 136$) received 10 Gy (1 Gy/day/3 fractions per week on alternate days), but after recommendations of DEGRO guidelines published in 2015, the remaining 19 patients (12.2%) received 6 Gy (1 Gy/day/3 fractions per week on alternate days).	To assess the effects of low-dose radiotherapy in patients diagnosed with greater trochanteric pain syndrome (GTPS) with recurrent symptoms or refractory to previous conservative measures.	At the pre-treatment visit, the mean (standard deviation, SD) visual analog scale (VAS) score was 8), which decreased to 5 (SD 2.2) after 1 month of the end of treatment and to 4 (SD 2.3) after 4 months. An objective symptom response with increased mobility, better sleep quality, and reduction of analgesic medication was found in 56% of patients at 1 month. In 129 patients (83.2%), there was a decrease of at least 1 point in the VAS score, and in 49 patients (29.0%), the VAS score was lower than 3. The mean length of follow-up was 45 months. The probability of maintaining the analgesic response estimated by the Kaplan-Meier method was 53% at 5 years.	2
147	Biete A, Valduvicio I, Cases C, et al: Analgesic effects of low-dose radiotherapy in greater trochanteric pain syndrome: results in a clinical series of 155 patients with recurrent or refractory symptoms. <i>Clin Transl Oncol</i> 24:846-853, 2022. doi.org/10.1007/s12094-021-02730-6	Prospective nonrandomized	We evaluated a total of 155 patients (90.3% women, mean age 69 years). Most patients ($n = 136$) received 10 Gy (1 Gy/day/3 fractions per week on alternate days), but after recommendations of DEGRO guidelines published in 2015, the remaining 19 patients (12.2%) received 6 Gy (1 Gy/day/3	To assess the effects of low-dose radiotherapy in patients diagnosed with greater trochanteric pain syndrome (GTPS) with recurrent symptoms or refractory to previous	At the pre-treatment visit, the mean (standard deviation, SD) visual analog scale (VAS) score was 8), which decreased to 5 (SD 2.2) after 1 month of the end of treatment and to 4 (SD 2.3) after 4 months. An objective symptom response with increased mobility, better sleep quality, and reduction of analgesic medication was found in 56% of patients at 1 month. In 129 patients (83.2%), there was a decrease of at least 1 point in the VAS score, and in 49 patients (29.0%), the VAS score was lower than 3. The mean length of	2

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			fractions per week on alternate days).	conservative measures.	follow-up was 45 months. The probability of maintaining the analgesic response estimated by the Kaplan-Meier method was 53% at 5 years.	
148	Valduvico I, Biete A, Moreno LA, et al: Is anti-inflammatory radiotherapy an effective treatment in trochanteritis? Br J Radiol 90, 2017:20160520. doi.org/10.1259/bjr.20160520	Prospective nonrandomized	We evaluated a total of 60 consecutive patients who received low-dose radiotherapy to achieve an anti-inflammatory and analgesic effect for recurrent trochanteritis following scarce response to conventional therapy. All patients were evaluated at baseline (prior to radiotherapy) and at 1 and 4 months after radiotherapy and then yearly thereafter for pain assessment using a visual analogue scale (VAS) and to determine the administration of analgesic treatment.	To evaluate the analgesic efficacy of low-dose radiotherapy in refractory cases of trochanteritis.	An improvement in the symptomatology was observed in 62% of the patients with a significant reduction in the VAS (8 ± 2 vs 4 ± 2 ; $p < 0.0001$), which was largely maintained until the second evaluation at 4 months. In the cases responding to radiotherapy, the probability of maintaining improvement beyond 24 months was 70%.	2
149	Staruch M, Gomez S, Rogers S, et al:Low-dose radiotherapy for greater trochanteric pain syndrome: a single-centre analysis. Strahlenther Onkol 200:128-133, 2024. doi.org/10.1007/s00066-023-02107-4	Prospectived nonrandomized	Patients with GTPS were irradiated on a linear accelerator with 0.5–1.0 Gy per fraction to a total dose of 3.0–4.0 Gy per series. The endpoint was subjective good response (GR) to treatment 2 months after completion of the last LDRT series, defined as complete pain relief or marked improvement assessed using the von Pannewitz score. A positive response to steroid injection (SI) was defined as pain relief of at least 7 days. Patient and treatment-related characteristics were evaluated with respect to LDRT outcomes.	To determine predictive factors associated with a good response (GR) to and efficacy of low-dose radiotherapy (LDRT) in patients with greater trochanteric pain syndrome (GTPS).	Outcomes were assessed for 71 peritrochanteric spaces (PTSs; 65 patients, 48 females, with mean age of 63 [44–91] years). Prior SI had been given to 55 (77%) PTSs and 40 PTSs received two series of LDRT. Two months after completion of LDRT, GR was reported in 42 PTSs (59%). Two series of LDRT provided a significantly higher rate of GR than one series (72.5 vs. 42% PTSs, $p = 0.015$). Temporary pain relief after prior SI predicted GR to LDRT compared with PTSs which had not responded to SI (73 vs. 28% PTSs, $p = 0.001$). A regional structural abnormality, present in 34 PTSs (48%), was associated with a reduction of GR to LDRT (44 vs. 73% PTSs, $p = 0.017$).	2
150	Niewald M, Seegenschmiedt MH, Mücke O, et al. Randomized, multicenter trial on the effect of radiation therapy on plantar fasciitis (painful heel spur) comparing a standard dose with a very low dose: mature results after 12 months' follow-up. Int J Radiat Oncol Biol Phys. Nov 15	Prospective randomized	Sixty-six patients were randomized to receive radiation therapy either with a total dose of 6.0 Gy applied in 6 fractions of 1.0 Gy twice weekly (standard dose) or with a total dose of 0.6 Gy applied in 6 fractions of 0.1 Gy twice weekly (low dose). In all	To conduct a randomized trial of radiation therapy for painful heel spur, comparing a standard dose with a very low dose.	Of 66 patients, 4 were excluded because of withdrawal of consent or screening failures. After 3 months the results in the standard arm were highly significantly superior compared with those in the low-dose arm (visual analogue scale, $P = .001$; Calcaneodynia score, $P = .027$; SF12, $P = .045$). The accrual of patients was stopped at this point. Further evaluation after 12 months'	1

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	2012;84(4):e455-62. doi:10.1016/j.ijrobp.2012.06.022		patients lateral opposing 4- to 6-MV photon beams were used. The results were measured using a visual analogue scale, the Calcaneodynia score, and the SF12 health survey. The fundamental phase of the study ended after 3 months, and the follow-up was continued up to 1 year. Patients with insufficient pain relief after 3 months were offered reirradiation with the standard dosage at any time afterward.		follow-up showed the following results: (1) highly significant fewer patients were reirradiated in the standard arm compared with the low-dose arm ($P < .001$); (2) the results of patients in the low-dose arm who were reirradiated were identical to those in the standard arm not reirradiated (reirradiation as a salvage therapy if the lower dose was ineffective); (3) patients experiencing a favorable result after 3 months showed this even after 12 months, and some results even improved further between 3 and 12 months	
151	Ott OJ, Hertel S, Gaipf US, Frey B, Schmidt M, Fietkau R. The Erlangen Dose Optimization trial for low-dose radiotherapy of benign painful elbow syndrome. Long-term results. <i>Strahlenther Onkol.</i> Mar 2014;190(3):293-7. doi:10.1007/s00066-013-0504-1	Prospective nonrandomized	Between February 2006 and February 2010, 199 evaluable patients were recruited for this prospective trial. All patients received low-dose orthovoltage radiotherapy. One course consisted of 6 fractions in 3 weeks. In the case of insufficient pain remission after 6 weeks, a second course was administered. Patients were randomly assigned to one of two groups to receive single doses of either 0.5 or 1.0 Gy. Endpoint was pain reduction. Pain was measured before radiotherapy, as well as immediately after (early response), 6 weeks after (delayed response) and approximately 3 years after (long-term response) completion of radiotherapy using a questionnaire-based visual analogue scale (VAS) and a comprehensive pain score (CPS).	To evaluate the long-term efficacy of pain reduction by two dose fractionation schedules used for low-dose radiotherapy of painful elbow syndrome.	Median follow-up was 35 months (range 9-57 months). The overall early, delayed and long-term response rates for all patients were 80, 90 and 94 %, respectively. The mean VAS scores before treatment and those for early, delayed and long-term response in the 0.5- and 1.0-Gy groups were 59.6 ± 20.2 and 55.7 ± 18.0 ($p = 0.46$); 32.1 ± 24.5 and 34.4 ± 22.5 ($p = 0.26$); 27.0 ± 27.7 and 23.5 ± 21.6 ($p = 0.82$) and 10.7 ± 15.0 and 21.5 ± 26.9 ($p = 0.12$), respectively. The mean CPS values before treatment and those for early, delayed and long-term response were 8.7 ± 2.9 and 8.1 ± 3.1 ($p = 0.21$); 4.5 ± 3.2 and 5.0 ± 3.4 ($p = 0.51$); 3.9 ± 3.6 and 2.8 ± 2.8 ($p = 0.19$) and 1.5 ± 2.3 and 2.4 ± 3.5 ($p = 0.27$), respectively. No significant differences in the quality of the long-term response were found between the 0.5- and 1.0-Gy arms ($p = 0.28$). Early or late treatment-related toxicities were reported.	2
152	Kim A, Kwon J, Kim JY, Kim BH. Comparative effectiveness of kilo- and megavoltage energies in low-dose radiotherapy for painful degenerative musculoskeletal diseases: a systematic review and meta-analysis. <i>Strahlenther</i>	Systematic review and meta-analysis	A systematic review was conducted in PubMed, Embase, and the Cochrane Library databases to identify studies with response information on the energy used (kilovoltage [kV] vs.	To assess the impact of different energy levels on the effectiveness of low-dose radiotherapy (LDRT) for treating	A total of 33 studies involving 12,143 patients were analyzed. Short-term follow-up (up to 6 months) showed a pooled ORR of 64% (95% CI 46-78%) for kV and of 62% (95% CI 54-70%) for MV. Long-term follow-up (at least 12 months) revealed a pooled ORR of 85% (95% CI 65-95%)	M

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	Onkol. May 2025;201(5):483-494. doi:10.1007/s00066-024-02329-0		megavoltage [MV]). The primary endpoint was the overall response rate (ORR), and the secondary endpoint was the complete response rate (CRR). Exploratory subgroup analyses included treatment site, study period, study design, country, and dose per fraction.	painful degenerative musculoskeletal diseases, as comparative efficacy data are currently lacking.	for kV and of 69% (95% CI 62-75%) for MV. Subgroup analysis indicated no significant differences in ORR for energy level stratified by treatment site and other factors. Regarding dose per fraction (0.5 Gy vs. 1.0 Gy), comparable ORRs were demonstrated between the two energies. No clinical side effects were noted.	
153	Canyilmaz E, Canyilmaz F, Aynaci O, et al. Prospective Randomized Comparison of the Effectiveness of Radiation Therapy and Local Steroid Injection for the Treatment of Plantar Fasciitis. Int J Radiat Oncol Biol Phys. Jul 1 2015;92(3):659-66. doi:10.1016/j.ijrobp.2015.02.009	Rprospective randomized	Between March 2013 and April 2014, 128 patients with plantar fasciitis were randomized to receive radiation therapy (total dose of 6.0 Gy applied in 6 fractions of 1.0 Gy three times a week) or local corticosteroid injections a 1 ml injection of 40 mg methylprednisolone and 0.5 ml 1% lidocaine under the guidance of palpation. The results were measured using a visual analog scale, a modified von Pannewitz scale, and a 5-level function score. The fundamental phase of the study was 3 months, with a follow-up period of up to 6 months.	The purpose of this study was to conduct a randomized trial of radiation therapy for plantar fasciitis and to compare radiation therapy with local steroid injections.	The median follow-up period for all patients was 12.5 months (range, 6.5-18.6 months). For the radiation therapy patients, the median follow-up period was 13 months (range, 6.5-18.5 months), whereas in the palpation-guided (PG) steroid injection arm, it was 12.1 months (range, 6.5-18.6 months). After 3 months, results in the radiation therapy arm were significantly superior to those in the PG steroid injection arm (visual analog scale, P<.001; modified von Pannewitz scale, P<.001; 5-level function score, P<.001). Requirements for a second treatment did not significantly differ between the 2 groups, but the time interval for the second treatment was significantly shorter in the PG steroid injection group (P=.045). This study confirms the superior analgesic effect of radiation therapy compared to mean PG steroid injection on plantar fasciitis for at least 6 months after treatment.	1
154	Gogna P, Gaba S, Mukhopadhyay R, Gupta R, Rohilla R, Yadav L. Plantar fasciitis: A randomized comparative study of platelet rich plasma and low dose radiation in sportspersons. Foot (Edinb). Aug 2016;28:16-19. doi:10.1016/j.foot.2016.08.002	Prospective randomized	All consecutive sportspersons presenting to our OPD with clinical diagnosis of plantar fasciitis underwent treatment consisting of stretching exercises, activity modification, and NSAID's for 6 months. First 40 patients who did not respond to the treatment were divided randomly into two groups of 20 patients each, Group A (Platelet rich plasma – PRP) and Group B (low dose radiation – LDR). At the time of final follow-up (6 months) the mean improvement in the pain score (Visual-Analogue-Scale),	To compare two common PRP and LDRT for treatment of plantar fasciitis	Significant improvement in all 3 parameters was noted at the time of final follow up within both groups. When compared to each other, the difference in outcome of both these Groups on the given 3 parameters came out to be insignificant (p > 0.05).	1

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			American Orthopaedic Foot and Ankle Score (AOFAS) and Plantar fascia thickness on ultrasound were compared.			
155	Rabadi D, Seo S, Wong B, Chung D, Rai V, Agrawal DK. Immunopathogenesis, early Detection, current therapies and prevention of plantar Fasciitis: A concise review. Int Immunopharmacol. Sep 2022;110:109023. doi:10.1016/j.intimp.2022.109023	Review	Literature review	To discuss the etiology, immunopathogenesis, current treatments of plantar fasciitis and potentially preventative measures prior to the onset of chronic treatment resistant plantar fasciitis	Plantar fasciitis or the inflammation of the fascial lining on the plantar aspect of the foot continues to be the leading cause of heel pain for many Americans. Common causes can range from anatomical deformities such as pes planus or flat foot, biomechanical etiology such as excessive pronation of the subtalar joint, or chronic diseases such as obesity and diabetes mellitus. The pathophysiology of plantar fasciitis can be either inflammatory due to vasodilation and immune system activation or non-inflammatory involving fibroblastic hypertrophy. Worsening pain of the inferior and medial heel after periods of prolonged rest and late in the day after hours of ambulation and weight-bearing activities is the most common symptom of plantar fasciitis. Common treatments for plantar fasciitis include plantar fascia stretching, physical therapy, orthotics, corticosteroid injections, and even surgery. Despite these treatment strategies, fasciitis remains a clinical problem and better treatment modalities are warranted. Late diagnosis is a common issue for prolonged and equivocal treatment and early diagnostic measures might be beneficial.	4
156	Young CC, Rutherford DS, Niedfeldt MW. Treatment of plantar fasciitis. Am Fam Physician. Feb 1 2001;63(3):467-74, 477-8.	Review	Literature review	To review treatment options for plantar fasciitis	Plantar fasciitis is a common cause of heel pain in adults. The disorder classically presents with pain that is particularly severe with the first few steps taken in the morning. In general, plantar fasciitis is a self-limited condition. However, symptoms usually resolve more quickly when the interval between the onset of symptoms and the onset of treatment is shorter. Many treatment options exist, including rest, stretching, strengthening, change of shoes, arch supports, orthotics, night splints, anti-inflammatory agents and surgery. Usually, plantar fasciitis can be treated successfully by tailoring treatment to an individual's risk factors and preferences.	4

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157	Weil LS, Jr., Roukis TS, Weil LS, Borrelli AH. Extracorporeal shock wave therapy for the treatment of chronic plantar fasciitis: indications, protocol, intermediate results, and a comparison of results to fasciotomy. J Foot Ankle Surg. May-Jun 2002;41(3):166-72. doi:10.1016/s1067-2516(02)80066-7	Retrospective	The results of 40 feet treated with this modality are reviewed after a mean follow-up time of 8.4 months. All procedures were performed under intravenous sedation and local infiltrative anesthesia. An electrohydraulic shock wave with a mean of 20.6 kV combined with a mean of 2,506 pulses was used. The results of a similar demographic class of patients having undergone a percutaneous plantar fasciotomy at our institution were compared to the results of this cohort of shock wave patients.	To review of the history, mechanism of action, and application of extracorporeal shock wave therapy for chronic plantar fasciitis	Eighty-two percent of the patients treated with extracorporeal shock wave therapy were successfully treated as compared to 83% with a percutaneous plantar fasciotomy. The mean score on the 11-point visual analog scale for satisfied patients was 7.9 preoperatively and 2.95 within 7 days postoperatively. After 3 months, the mean visual analog score was 4.2 or 50% of the preoperative value after a mean of 8.4 months following treatment. Eighty-three percent of the patients treated stated that shock wave therapy improved their symptoms. There were no complications encountered in any patient in this study. Extracorporeal shock wave therapy is an effective treatment, which significantly reduces the symptoms associated with chronic plantar fasciitis and compares favorably to the results achieved with surgical intervention in the form of a percutaneous plantar fasciotomy.	3
158	Hammer DS, Rupp S, Kreutz A, Pape D, Kohn D, Seil R. Extracorporeal shockwave therapy (ESWT) in patients with chronic proximal plantar fasciitis. Foot Ankle Int. Apr 2002;23(4):309-13. doi:10.1177/107110070202300403	Prospective randomized	Forty-seven patients (49 feet) with a previously unsuccessful conservative treatment of at least six months were randomized to two groups. Treatment of Group 1 (25 heels) started immediately with three sessions of ESWT (3000 shockwaves/session of 0.2 mJ/mm ²) at weekly intervals.	To compare the effect of extracorporeal shockwave therapy (ESWT) in patients with chronically painful proximal plantar fasciitis with a conventional conservative treatment consisting of nonsteroidal anti-inflammatory drugs, heel cup, orthoses and/or shoe modifications, local steroid injections and electrotherapy.	In the patients of Group 2 (24 heels) treatment was continued for 12 weeks. After this period they were treated using the protocol of Group 1. No significant difference of pain and walking time after further non-ESWT treatment (three months) was seen. Six months after ESWT pain decreased by 64% to 88% on the visual analog scale (VAS) and the comfortable walking time had increased significantly in both groups.	1
159	Burnham R, Gregg R, Healy P, Steadward R. The effectiveness of topical diclofenac for lateral epicondylitis. Clin J Sport Med. Apr 1998;8(2):78-81. doi:10.1097/00042752-199804000-00002	Prospective nonrandomized	A sample of 14 subjects meeting clinical criteria of chronic lateral epicondylitis participated in this randomized, double blind, crossover study. Each subject applied a pluronic lecithin	To determine the effectiveness of topical diclofenac as a treatment of lateral epicondylitis	When subjects used diclofenac PLO, pain was significantly less than that during the pretreatment, washout, and placebo PLO periods (mean VAS: diclofenac PLO, 2.1; pretreatment, 3.5; washout, 3.4; placebo PLO, 3.6). Average wrist extension strength was significantly greater	2

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			liposomal organo-gel (PLO) over the affected lateral elbow three times daily for 1 week, followed by a 1-week "washout" period of no gel. A second topical PLO gel was then applied similarly for 1 week. Both gels were identical, but only one gel contained 2% diclofenac. Treatment order was randomized, and both the subject and tester were blinded. Pain and isometric wrist extension strength were measured using a visual analog pain scale (VAS) and a mounted manual muscle testing dynamometer, respectively, at the following time periods: just before application of the first gel, the last day of using the first gel, the last day of the washout week, and the last day of using the second gel. Analysis was performed using repeated measures analysis of variance.		when subjects used diclofenac PLO (8.4 kg) than it was before treatment (5.9 kg). One subject developed a local rash while using diclofenac PLO.	
160	Labelle H, Guibert R. Efficacy of diclofenac in lateral epicondylitis of the elbow also treated with immobilization. The University of Montreal Orthopaedic Research Group. Arch Fam Med. May-Jun 1997;6(3):257-62. doi:10.1001/archfami.6.3.257	Prospective randomized	Multicenter double-blind randomized controlled trial in which the following hypothesis was tested: whether diclofenac sodium provided a 20% or greater improvement over rest and cast immobilization in the response rate to treatment of lateral epicondylitis beyond and over rest in an experimental group compared with a control group after 4 weeks of treatment. During a 1-year period, 206 subjects aged 18 to 60 years with lateral epicondylitis were recruited from the clientele treated by family physicians. Thirty subjects refused to participate and 47 presented	To evaluate the efficacy of an oral nonsteroidal anti-inflammatory drug in the treatment of lateral epicondylitis.	The experimental group was treated with a daily dose of diclofenac sodium (150 mg) for 28 days, while the control group received a placebo during the same period. In addition, both groups were immobilized in a cast for 14 days and were told not to perform repetitive movements of the involved limb for 21 days. Measuring instruments consisted of grip strength measurements with a squeeze dynamometer, a visual analog pain scale, a visual analog function scale, and an 8-item pain-free function index. A statistically and clinically significant reduction of pain was associated with treatment with diclofenac, but no clinically significant difference in grip strength or functional improvement could be detected between the 2 groups. Secondary effects (diarrhea and abdominal pain) were significantly more frequent in the diclofenac-treated group.	1

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			with exclusion criteria, leaving 129 subjects who entered the study. One subject withdrew after 21 days.			
161	Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. Br J Sports Med. Jul 2005;39(7):411-22; discussion 411-22. doi:10.1136/bjsm.2004.016170	Systematic review and meta-analysis	A systematic review of the literature on the effectiveness of physical interventions for lateral epicondylalgia (tennis elbow) was carried out. Seventy six randomised controlled trials were identified, 28 satisfied the minimum criteria for meta-analysis.	To examine efficacy of physical interventions for lateral epicondylalgia	The evidence suggests that extracorporeal shock wave therapy is not beneficial in the treatment of tennis elbow. There is a lack of evidence for the long term benefit of physical interventions in general. However, further research with long term follow up into manipulation and exercise as treatments is indicated.	M
162	*Verhaar JA. Tennis elbow. Anatomical, epidemiological and therapeutic aspects. Int Orthop. Oct 1994;18(5):263-7. doi:10.1007/BF00180221	Review	Literature reviews	To examine anatomical, epidemiological and therapeutic aspects of tennis elbow	Five studies of tennis elbow are presented. Epidemiological studies showed an incidence of tennis elbow between 1 and 2%. The prevalence of tennis elbow in women between 40 and 50 years of age was 10%. Half of the patients with tennis elbow seek medical attention. Local corticosteroid injections were superior to the physiotherapy regime of Cyriax. Release of the common forearm extensor origin resulted in 70% excellent or good results one year after operation and 89% at five years. Anatomical investigations and nerve conduction studies of the Radial Tunnel Syndrome supported the hypothesis that the Lateral Cubital Force Transmission System is involved in the pathogenesis of tennis elbow.	4
163	Ruiz SG, DeVos MJ, Warth RJ, et al: Treatment of lateral epicondylitis: is surgery still an option? Eplasty 24:e18,2024	Retrospective	A cross-sectional analysis of the Texas health care database from 2010 to 2018 was performed. We analyzed all procedures performed for LE during the set time period using Current Procedure Terminology (CPT) codes. Statistical analyses included procedures performed, patient demographics, zone of residence, and insurance designation.	To analyze epidemiological changes in lateral epicondylitis (LE) surgery	There were a total of 12802 records of LE with 1 or more associated surgical procedures. Lateral epicondylar debridement (with/without tendon repair) was the most common procedure recorded, followed by arthroscopic procedures and tendon lengthening. Overall incidence remained low and did not significantly change during the studied period; however, surgical case volumes were significantly higher in metropolitan areas and increased at a faster rate when compared with those of more rural regions. Commercial insurance was the most prevailing form of payment. The incidence was significantly higher in the age group between 45 and 64 years old and most commonly performed in Caucasian females.	3

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164	Coombes BK, Bisset L, Brooks P, Khan A, Vicenzino B. Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. JAMA. Feb 6 2013;309(5):461-9. doi:10.1001/jama.2013.129	Prospective randomized	A 2 × 2 factorial, randomized, injection-blinded, placebo-controlled trial was conducted at a single university research center and 16 primary care settings in Brisbane, Australia. A total of 165 patients aged 18 years or older with unilateral lateral epicondylalgia of longer than 6 weeks' duration were enrolled between July 2008 and May 2010; 1-year follow-up was completed in May 2011. Corticosteroid injection (n = 43), placebo injection (n = 41), corticosteroid injection plus physiotherapy (n = 40), or placebo injection plus physiotherapy (n = 41). The 2 primary outcomes were 1-year global rating of change scores for complete recovery or much improvement and 1-year recurrence (defined as complete recovery or much improvement at 4 or 8 weeks, but not later) analyzed on an intention-to-treat basis (P < .01). Secondary outcomes included complete recovery or much improvement at 4 and 26 weeks.	To investigate the effectiveness of corticosteroid injection, multimodal physiotherapy, or both in patients with unilateral lateral epicondylalgia.	Corticosteroid injection resulted in lower complete recovery or much improvement at 1 year vs placebo injection (83% vs 96%, respectively; relative risk [RR], 0.86 [99% CI, 0.75-0.99]; P = .01) and greater 1-year recurrence (54% vs 12%; RR, 0.23 [99% CI, 0.10-0.51]; P < .001). The physiotherapy and no physiotherapy groups did not differ on 1-year ratings of complete recovery or much improvement (91% vs 88%, respectively; RR, 1.04 [99% CI, 0.90-1.19]; P = .56) or recurrence (29% vs 38%; RR, 1.31 [99% CI, 0.73-2.35]; P = .25). Similar patterns were found at 26 weeks, with lower complete recovery or much improvement after corticosteroid injection vs placebo injection (55% vs 85%, respectively; RR, 0.79 [99% CI, 0.62-0.99]; P < .001) and no difference between the physiotherapy and no physiotherapy groups (71% vs 69%, respectively; RR, 1.22 [99% CI, 0.97-1.53]; P = .84). At 4 weeks, there was a significant interaction between corticosteroid injection and physiotherapy (P = .01), whereby patients receiving the placebo injection plus physiotherapy had greater complete recovery or much improvement vs no physiotherapy (39% vs 10%, respectively; RR, 4.00 [99% CI, 1.07-15.00]; P = .004). However, there was no difference between patients receiving the corticosteroid injection plus physiotherapy vs corticosteroid alone (68% vs 71%, respectively; RR, 0.95 [99% CI, 0.65-1.38]; P = .57). Among patients with chronic unilateral lateral epicondylalgia, the use of corticosteroid injection vs placebo injection resulted in worse clinical outcomes after 1 year, and physiotherapy did not result in any significant differences.	1
165	Yao L, Xiong Y, Ma W, Li J, Tang X. Arthroscopic Suture Anchor Repair and Debridement for Refractory Lateral Epicondylitis Show Significant Clinical Improvement. Arthroscopy. Aug 2025;41(8):2821-2830 e1. doi:10.1016/j.arthro.2024.11.070	Retrospective	Patients with refractory lateral epicondylitis who underwent arthroscopic surgery between August 2018 and September 2022 with a minimum 1-year follow-up were included. All patients were divided into 2 groups based on whether they	To retrospectively compare the clinical outcomes of arthroscopic suture anchor repair of the common extensor tendon (CET) and arthroscopic	A total of 62 patients (60% female) were included in the final analysis (30 in the debridement group and 32 in the repair group). The mean age of the cohort was 47.6 ± 7.3 years, with 77% affecting the dominant arm. The follow-up time was 29.3 ± 3.2 (range, 19-35) months for the debridement group and 27.2 ± 5.4 (range, 20-37) months for the repair group (P = .073). Preoperative patient-	3

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			underwent suture anchor repair. The modified Nirschl technique was used to debride the CET lesions in all patients, and modified anchor repair was used for CET insertion reconstruction in patients after January 2021. In short, suture anchor fixation (single-row) was used in patients with tear areas less than 50% of the CET insertion, and suture bridge fixation (double-row) was used in patients with tear areas greater than 50%. The outcomes, including the visual analog scale (VAS) score for pain, the Mayo Elbow Performance Score (MEPS), the quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score, and surgical satisfaction, were measured 1 day preoperatively and at the latest follow-up. The proportion of patients achieving the minimal clinically important difference (MCID) was compared between the groups.	debridement of CET for the treatment of refractory lateral epicondylitis.	reported outcomes were comparable between the groups and significantly improved after surgery. Postoperatively, patients in the repair group had a better MEPS score (95.8 ± 6.9 vs 91.2 ± 8.0 ; $P = .017$) and QuickDASH scores (2.2 ± 3.9 vs 4.2 ± 3.9 ; $P = .043$), while there were no differences between the 2 groups in terms of VAS scores for pain during rest (0.1 ± 0.4 vs 0.1 ± 0.3 ; $P = .933$) or during activity (0.3 ± 0.8 vs 0.4 ± 0.6 ; $P = .639$). MCID achievement of VAS score during rest was similar between the repair group (97%) and the debridement group (93%, $P = .607$), while MCID achievement in the VAS score during activity, MEPS score, and QuickDASH score was 100% in both groups. All patients resumed their daily life and work after surgery, for a surgical satisfaction rate of 98.4%. Arthroscopic suture anchor repair and debridement of the CET insertion resulted in significant clinical improvement in patients with refractory lateral epicondylitis.	
166	Mellor R, Bennell K, Grimaldi A, et al. Education plus exercise versus corticosteroid injection use versus a wait and see approach on global outcome and pain from gluteal tendinopathy: prospective, single blinded, randomised clinical trial. Br J Sports Med. Nov 2018;52(22):1464-1472. doi:10.1136/bjsports-2018-k1662rep	Prospective randomized	Prospective, three arm, single blinded, randomised clinical trial. Individuals aged 35-70 years, with lateral hip pain for more than 3 months, at least 4/10 on the pain numerical rating scale, and gluteal tendinopathy confirmed by clinical diagnosis and MRI; and with no corticosteroid injection use in previous 12 months, current physiotherapy, total hip replacement, or neurological conditions. A physiotherapy led education and exercise programme of 14 sessions over 8 weeks (EDX; n=69), one corticosteroid injection (CSI);	To compare the effects of a programme of load management education plus exercise, corticosteroid injection use, and no treatment on pain and global improvement in individuals with gluteal tendinopathy.	Of 204 randomised participants (including 167 women; mean age 54.8 years (SD 8.8)), 189 (92.6%) completed 52 week follow-up. Success on the global rating of change was reported at 8 weeks by 51/66 EDX, 38/65 CSI, and 20/68 WS participants. EDX and CSI had better global improvement scores than WS (risk difference 49.1% (95% CI 34.6% to 63.5%), number needed to treat 2.0 (95% CI 1.6 to 2.9); 29.2% (13.2% to 45.2%), 3.4 (2.2 to 7.6); respectively). EDX had better global improvement scores than CSI (19.9% (4.7% to 35.0%); 5.0 (2.9 to 21.1)). At 8 weeks, reported pain on the numerical rating scale was mean score 1.5 (SD 1.5) for EDX, 2.7 (2.4) for CSI, and 3.8 (2.0) for WS. EDX and CSI participants reported less pain than WS (mean difference -2.2 (95% CI -2.89 to -1.54); -1.2 (-1.85	1

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			n=66), and a wait and see approach (WS; n=69). Primary outcomes were patient reported global rating of change in hip condition (on an 11 point scale, dichotomised to success and non-success) and pain intensity in the past week (0=no pain, 10=worst pain) at 8 weeks, with longer term follow-up at 52 weeks.		to -0.50); respectively), and EDX participants reported less pain than CSI (-1.04 (-1.72 to -0.37)). Success on the global rating of change was reported at 52 weeks by 51/65 EDX, 36/63 CSI, and 31/60 WS participants; EDX was better than CSI (20.4% (4.9% to 35.9%); 4.9 (2.8 to 20.6)) and WS (26.8% (11.3% to 42.3%); 3.7 (2.4 to 8.8)). Reported pain at 52 weeks was 2.1 (2.2) for EDX, 2.3 (1.9) for CSI, and 3.2 (2.6) for WS; EDX did not differ from CSI (-0.26 (-1.06 to 0.55)), but both treatments did better than WS (1.13 (-1.93 to -0.33); 0.87 (-1.68 to -0.07); respectively). For gluteal tendinopathy, education plus exercise and corticosteroid injection use resulted in higher rates of patient reported global improvement and lower pain intensity than no treatment at eight weeks. Education plus exercise performed better than corticosteroid injection use. At 52 week follow-up, education plus exercise led to better global improvement than corticosteroid injection use, but no difference in pain intensity. These results support EDX as an effective management approach for gluteal tendinopathy.	
167	Disantis A, Andrade AJ, Baillou A, et al. The 2022 International Society for Hip Preservation (ISHA) physiotherapy agreement on assessment and treatment of greater trochanteric pain syndrome (GTPS): an international consensus statement. J Hip Preserv Surg. Jan 2023;10(1):48-56. doi:10.1093/jhps/hnac050	Guidelines	The 2022 International Society of Hip Preservation (ISHA) physiotherapy agreement on assessment and treatment of greater trochanteric pain syndrome (GTPS) was intended to present a physiotherapy consensus on the assessment and surgical and non-surgical physiotherapy management of patients with GTPS.	To provide guidelines fo treatment of GTPS	The panel consisted of 15 physiotherapists and eight orthopaedic surgeons. Currently, there is a lack of high-quality literature supporting non-operative and operative physiotherapy management. Therefore, a group of physiotherapists who specialize in the treatment of non-arthritic hip pathology created this consensus statement regarding physiotherapy management of GTPS. The consensus was conducted using a modified Delphi technique to guide physiotherapy-related decisions according to the current knowledge and expertise regarding the following: (i) evaluation of GTPS, (ii) non-surgical physiotherapy management, (iii) use of corticosteroids and orthobiologics and (iv) surgical indications and post-operative physiotherapy management.	4
168	Thorlund JB, Juhl CB, Roos EM, Lohmander LS. Arthroscopic surgery for degenerative knee: systematic review and meta-analysis of benefits and harms. BMJ.	Systematic review and meta-analysis	Systematic searches for benefits and harms were carried out in Medline, Embase, CINAHL, Web of Science, and the Cochrane	To determine benefits and harms of arthroscopic knee surgery involving	The search identified nine trials assessing the benefits of knee arthroscopic surgery in middle aged and older patients with knee pain and degenerative knee disease. The main analysis,	M

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	Jun 16 2015;350:h2747. doi:10.1136/bmj.h2747		Central Register of Controlled Trials (CENTRAL) up to August 2014. Only studies published in 2000 or later were included for harms.	partial meniscectomy, debridement, or both for middle aged or older patients with knee pain and degenerative knee disease.	combining the primary endpoints of the individual trials from three to 24 months postoperatively, showed a small difference in favour of interventions including arthroscopic surgery compared with control treatments for pain (effect size 0.14, 95% confidence interval 0.03 to 0.26). This difference corresponds to a benefit of 2.4 (95% confidence interval 0.4 to 4.3) mm on a 0-100 mm visual analogue scale. When analysed over time of follow-up, interventions including arthroscopy showed a small benefit of 3-5 mm for pain at three and six months but not later up to 24 months. No significant benefit on physical function was found (effect size 0.09, -0.05 to 0.24). Nine studies reporting on harms were identified. Harms included symptomatic deep venous thrombosis (4.13 (95% confidence interval 1.78 to 9.60) events per 1000 procedures), pulmonary embolism, infection, and death. The small inconsequential benefit seen from interventions that include arthroscopy for the degenerative knee is limited in time and absent at one to two years after surgery. Knee arthroscopy is associated with harms. Taken together, these findings do not support the practise of arthroscopic surgery for middle aged or older patients with knee pain with or without signs of osteoarthritis.	
169	Lowry V, Lavigne P, Zidarov D, Matifat E, Cormier AA, Desmeules F. A Systematic Review of Clinical Practice Guidelines on the Diagnosis and Management of Various Shoulder Disorders. Arch Phys Med Rehabil. Feb 2024;105(2):411-426. doi:10.1016/j.apmr.2023.09.022	Systematic review	A systematic search of CPGs on specific shoulder disorders was conducted up to August 2022 in relevant databases. Twenty-six CPGs on rotator cuff (RC) tendinopathy, RC tear, calcific tendinitis, adhesive capsulitis, glenohumeral (GH) instability, GH osteoarthritis, or acromioclavicular disorders published from January 2008 onward were screened and included. CPGs methodological quality was assessed with the AGREE II checklist. All recommendations from CPGs	To perform a systematic review of clinical practice guidelines (CPGs) covering the management of common shoulder disorders.	Only 12 CPGs (46%) were of high quality with major limitations related to the applicability and editorial independence of the guidelines. The initial evaluation of shoulder pain should include patient's history, subjective evaluation focused on red flags, and clinical examination. Magnetic resonance imaging is usually not recommended to manage early shoulder pain, and recommendations for X-rays are conflicting. Acetaminophen, oral non-steroidal anti-inflammatory drugs, and rehabilitation including exercises were recommended or may be recommended to treat all shoulder pain disorders. Guidelines on surgical management recommendations differed; for example, 6 CPGs reported that acromioplasty was recommended	4

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			were extracted and categorized by shoulder disorder and care components (evaluation, diagnostic imaging, medical, rehabilitation, and surgical treatments). After semantic analysis of the terminology, recommendations for each shoulder disorders were classified by 2 reviewers into “recommended,” “may be recommended,” or “not recommended.” Disagreements were resolved by discussion until reviewers reached consensus.		or may be recommended in chronic RC tendinopathy, whereas 4 CPGs did not recommend it.	
170	Garving C, Jakob S, Bauer I, Nadjar R, Brunner UH. Impingement Syndrome of the Shoulder. Dtsch Arztebl Int. Nov 10 2017;114(45):765-776. doi:10.3238/arztebl.2017.0765	Review	Literature review	To examine literature regarding treatment of shoulder impingement syndrome	Patients with shoulder impingement syndrome suffer from painful entrapment of soft tissue whenever they elevate the arm. The pathological mechanism is a structural narrowing in the subacromial space. A multiplicity of potential etiologies makes the diagnosis more difficult; it is established by the history and physical examination and can be confirmed with x-ray, ultra - sonography, and magnetic resonance imaging. The initial treatment is conservative, e.g., with nonsteroidal antiinflammatory drugs, infiltrations, and patient exercises. Conservative treatment yields satisfactory results within 2 years in 60% of cases. If symptoms persist, decompressive surgery is performed as long as the continuity of the rotator cuff is preserved and there is a pathological abnormality of the bursa. The correct etiologic diagnosis and choice of treatment are essential for a good outcome. The formal evidence level regarding the best treatment strategy is low, and it has not yet been determined whether surgical or conservative treatment is better.	4
171	Mucke R SU, Micke O, Seegenschmiedt MH, Kriz J. Radiotherapy for benign diseases. Specialist group-specific evidence-based S2e guideline of the German Society for Radiation Oncology (DEGRO). V3.0	Systematic review and guidelines	A systematic search, selection, and evaluation of scientific evidence on the relevant clinical questions was conducted and guidelines were developed	To provide a detailed update of the guideline first published in October 1999 and extensively updated	Irradiation of osteoarthritis of small joints is a successful, low-cost, low-risk therapy that is an alternative to other forms of therapy. However, because of the general risk of radiation, a careful risk-benefit assessment must be made in younger patients, for instance below the age of	4

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	https://www.degro.org/wp-content/uploads/2024/10/S2e-Guideline-Radiotherapy-of-Benign-Diseases-Ready-Final-Version-Englisch-USA.pdf			in 2018. It takes into account the broad spectrum of indications for radiotherapy of nonmalignant diseases in 2022 in German-speaking countries.	40 years. A total of 75% of patients with osteoarthritis of small joints benefit from analgesic irradiation. Even after >5 years, sustained pain relief can be achieved in more than half of these patients. Radiation therapy with 6.0 Gy promises good success not only after a large number of pretreatments but also for patients with a pain history of >10 years. Although radiotherapy should be started early in the course of the disease, there are no significant differences in the success of therapy with regard to the duration of symptoms. Localization, age, or sex are also not influencing factors. A second series of irradiation leads to success in >80% of patients. Even a third can still improve pain but not to the same extent as the second series. Considering the radiation protection, with the age distribution of the patients (median, 65 years), the tumor risk is negligible. For the dose ranges used in radiotherapy of joint arthrosis, no tumor induction has been reported in literature.	
172	*Hamada N, Fujimichi Y. Classification of radiation effects for dose limitation purposes: history, current situation and future prospects. J Radiat Res. Jul 2014;55(4):629-40. doi:10.1093/jrr/rru019	Review	NA	To review the changes in radiation effect classification, dose limitation concepts, and the definition of detriment and threshold. Then, the current situation is overviewed focusing on (i) stochastic effects with a threshold, (ii) tissue reactions without a threshold, (iii) target organs/tissues for circulatory disease, (iv) dose levels for limitation of cancer risks vs prevention of non-life-threatening tissue reactions vs prevention of life-	Radiation exposure causes cancer and non-cancer health effects, each of which differs greatly in the shape of the dose-response curve, latency, persistency, recurrence, curability, fatality and impact on quality of life. In recent decades, for dose limitation purposes, the International Commission on Radiological Protection has divided such diverse effects into tissue reactions (formerly termed non-stochastic and deterministic effects) and stochastic effects. On the one hand, effective dose limits aim to reduce the risks of stochastic effects (cancer/heritable effects) and are based on the detriment-adjusted nominal risk coefficients, assuming a linear-non-threshold dose response and a dose and dose rate effectiveness factor of 2. On the other hand, equivalent dose limits aim to avoid tissue reactions (vision-impairing cataracts and cosmetically unacceptable non-cancer skin changes) and are based on a threshold dose. However, the boundary between these two categories is becoming vague.	4

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				threatening tissue reactions, (v) mortality or incidence of thyroid cancer, and (vi) the detriment for tissue reactions.		
173	Zwicker F, Kirchner C, Huber PE, Debus J, Zwicker H, Klepper R. Breast cancer occurrence after low dose radiotherapy of non-malignant disorders of the shoulder. Sci Rep. Mar 28 2019;9(1):5301. doi:10.1038/s41598-019-41725-w	Retrospective	In a geographically defined district with a population of approximately 100,000 inhabitants, comprehensive data of radiological diagnostics and radiotherapy were registered nearly completely for 41 years; data included mammography and radiotherapy of breast cancer patients as well as of non-malignant disorders. Within this population a collective of 158 women with radiotherapy of the shoulder was investigated. Radiotherapy was performed with cobalt-60 photons (Gammatron) with an average cumulative-dose of 6 Gy. The average follow-up time was 21.3 years. Patients were 55 years old (median) when radiotherapy of the shoulder was performed.	To investigate the occurrence of breast cancer in female patients after radiotherapy of non-malignant disorders of the shoulder and made a comparison with the estimated spontaneous incidence of mammary carcinoma for this cohort.	In this study, a geographically defined district with a population of approximately 100,000 inhabitants was retrospectively analyzed as far back as 41 years with comprehensive review of radiologic diagnostics data, including mammography and RT records of patients with breast cancer and other nonmalignant disorders. Within this population, 158 women who underwent LDRT of the shoulder were investigated. RT was performed with cobalt-60 photons with an average cumulative dose of 6 Gy. Median age was 55 years old when RT of the shoulder was performed, with an average follow-up time of 21.3 years Seven patients (4.4%) developed breast cancer after a median of 21 years. According to the incidence statistics, 9.4 +/- 1.8 (95%CI) cases (5.9%) would be expected in a control study population. In regard to the irradiated shoulder neither the ipsilateral nor the contralateral breasts showed increased rates of breast cancer. An induction of additional breast cancer caused by radiation of non-malignant disorders of the shoulder wasn't detected in the investigated cohort.	3
174	*Brenner DJ, Doll R, Goodhead DT, et al. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. Proc Natl Acad Sci U S A. Nov 25 2003;100(24):13761-6. doi:10.1073/pnas.2235592100	Review	NA	To review the difficulties involved in quantifying the risks of low-dose radiation and address two specific questions. First, what is the lowest dose of x- or gamma-radiation for which good evidence exists of increased cancer risks in humans?	What is the lowest dose of x- or gamma-radiation for which good evidence exists of increased cancer risks in humans? The epidemiological data suggest that it is approximately 10-50 mSv for an acute exposure and approximately 50-100 mSv for a protracted exposure. What is the most appropriate way to extrapolate such cancer risk estimates to still lower doses? Given that it is supported by experimentally grounded, quantifiable, biophysical arguments, a linear extrapolation of cancer risks from intermediate to very low doses currently appears to be the most appropriate methodology. This	4

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				Second, what is the most appropriate way to extrapolate such cancer risk estimates to still lower doses?	linearity assumption is not necessarily the most conservative approach, and it is likely that it will result in an underestimate of some radiation-induced cancer risks and an overestimate of others.	
175	*Cardis E, Vrijheid M, Blettner M, et al. Risk of cancer after low doses of ionising radiation: retrospective cohort study in 15 countries. <i>BMJ</i> . Jul 9 2005;331(7508):77. doi:10.1136/bmj.38499.599861.E0	Retrospective cohort	Multinational retrospective cohort study of cancer mortality. Cohorts of workers in the nuclear industry in 15 countries. 407 391 workers individually monitored for external radiation with a total follow-up of 5.2 million person years. Estimates of excess relative risks per sievert (Sv) of radiation dose for mortality from cancers other than leukaemia and from leukaemia excluding chronic lymphocytic leukaemia, the main causes of death considered by radiation protection authorities.	To provide direct estimates of risk of cancer after protracted low doses of ionising radiation and to strengthen the scientific basis of radiation protection standards for environmental, occupational, and medical diagnostic exposures.	The excess relative risk for cancers other than leukaemia was 0.97 per Sv, 95% confidence interval 0.14 to 1.97. Analyses of causes of death related or unrelated to smoking indicate that, although confounding by smoking may be present, it is unlikely to explain all of this increased risk. The excess relative risk for leukaemia excluding chronic lymphocytic leukaemia was 1.93 per Sv (< 0 to 8.47). On the basis of these estimates, 1-2% of deaths from cancer among workers in this cohort may be attributable to radiation. These estimates, from the largest study of nuclear workers ever conducted, are higher than, but statistically compatible with, the risk estimates used for current radiation protection standards. The results suggest that there is a small excess risk of cancer, even at the low doses and dose rates typically received by nuclear workers in this study.	3
176	*Sachs RK, Shuryak I, Brenner D, Fakir H, Hlatky L, Hahnfeldt P. Second cancers after fractionated radiotherapy: stochastic population dynamics effects. <i>J Theor Biol</i> . Dec 7 2007;249(3):518-31. doi:10.1016/j.jtbi.2007.07.034	Review	Investigation into modeling for second cancers to provide unique insights into human carcinogenesis, since the therapy involves administering well characterized doses of a well studied carcinogen, followed by long-term monitoring.	To estimate the risk of solid second cancers using modeling while considering long latency times, and the fact that available data is usually for older, obsolescent treatment regimens.	In addition to putative radiation initiation that produces pre-malignant cells, inactivation (i.e. cell killing), and subsequent cell repopulation by proliferation can be important at the doses relevant to second cancer situations. A recent initiation/inactivation/proliferation (IIP) model characterized quantitatively the observed occurrence of second breast and lung cancers, using a deterministic cell population dynamics approach. To analyze if radiation-initiated pre-malignant clones become extinct before full repopulation can occur, we here give a stochastic version of this IIP model. Combining Monte Carlo simulations with standard solutions for time-inhomogeneous birth-death equations, we show that repeated cycles of inactivation and repopulation, as occur during fractionated radiation therapy, can lead to distributions of	4

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					pre-malignant cells per patient with variance >> mean, even when pre-malignant clones are Poisson-distributed. Thus fewer patients would be affected, but with a higher probability, than a deterministic model, tracking average pre-malignant cell numbers, would predict. Our results are applied to data on breast cancers after radiotherapy for Hodgkin disease. The stochastic IIP analysis, unlike the deterministic one, indicates: a) initiated, pre-malignant cells can have a growth advantage during repopulation, not just during the longer tumor latency period that follows; b) weekend treatment gaps during radiotherapy, apart from decreasing the probability of eradicating the primary cancer, substantially increase the risk of second cancers.	
177	*Jansen JT, Broerse JJ, Zoetelief J, Klein C, Seegenschmiedt HM. Estimation of the carcinogenic risk of radiotherapy of benign diseases from shoulder to heel. Radiother Oncol. Sep 2005;76(3):270-7. doi:10.1016/j.radonc.2005.06.034	Preclinical	The carcinogenic risk is estimated by applying the effective dose concept from the ICRP with the average risk factor of 10% per Sv for high dose and high dose rate. Although, the concept of effective dose for the present study has limitations, its use is considered acceptable for a fairly rough risk estimate. The organ doses are calculated using a Monte Carlo radiation transport code and anthropomorphic mathematical phantoms. Special risk modifying factors like patient's age at exposure and gender are taken into account.	To estimate risk on fatal tumour induction in patients by radiotherapy of benign diseases at various body sites, including heterotopic ossification, omarthritis, gonarthrosis, heel spurs and hidradenitis suppurativa.	For the treatment of heterotopic ossification, omarthritis, gonarthrosis, heel spurs and hidradenitis suppurativa the effective dose is in the range of 5-400 mSv. For an average-aged population, the estimated number of radiation-induced fatal tumours due to these treatments is assessed to be between 0.5 and 40 persons per 1000 patients treated. At higher ages the risks are reduced. In this study, the estimated lifetime risk for an induced fatal tumor for a patient receiving LDRT with total dose of 6 Gy for knee OA at the age of 25, 50, and 70 was 2 in 1000, 0.7 in 1000, and 0.3 in 1000 patients, respectively, when assuming an estimated effective dose of 13 mSv (which, of note, is an effective dose similar to an abdominopelvic computed tomography scan).	4
178	*Shuryak I, Sachs RK, Brenner DJ. Cancer risks after radiation exposure in middle age. J Natl Cancer Inst. Nov 3 2010;102(21):1628-36. doi:10.1093/jnci/djq346	Retrospective	Retrospective review of data for radiation-induced malignancies with correlation to age at time of RT exposure	To analyze observed cancer risk patterns as a function of age at exposure in Japanese atomic bomb survivors by using a biologically based quantitative model of radiation carcinogenesis that incorporates both	Radiation risks after exposure in younger individuals are dominated by initiation processes, whereas radiation risks after exposure at later ages are more influenced by promotion of preexisting premalignant cells. Thus, the cancer site-dependent balance between initiation and promotion determines the dependence of cancer risk on age at radiation exposure. For example, in terms of radiation induction of premalignant cells, a quantitative measure of the relative contribution of initiation vs promotion is 10-fold	3

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				radiation induction of premalignant cells (initiation) and radiation-induced promotion of premalignant damage. This approach emphasizes the kinetics of radiation-induced initiation and promotion, and tracks the yields of premalignant cells before, during, shortly after, and long after radiation exposure.	larger for breast cancer than for lung cancer. Reflecting this difference, radiation-induced breast cancer risks decrease with age at exposure at all ages, whereas radiation-induced lung cancer risks do not.	
179	*Trott KR, Kamprad F. Estimation of cancer risks from radiotherapy of benign diseases. Strahlenther Onkol. Aug 2006;182(8):431-6. doi:10.1007/s00066-006-1542-8	Retrospective	The risk of cancer induction by radiotherapy of benign diseases should be based on epidemiologic data directly derived from follow-up studies of patients who had been given radiotherapy for nonmalignant diseases in the past.	To discuss the effective-dose method which was proposed by the ICRP (International Commission of Radiation Protection) for the estimation of risk to the general population from occupational or environmental, low-dose radiation exposure is not adequate for estimating the risk of cancer induction by radiotherapy of malignant or nonmalignant diseases.	Risk factors were derived from epidemiologic studies of patients treated with irradiation for nonmalignant diseases to be used for selecting treatment options and optimizing treatment procedures. In most cases, cancer risks estimated by the effective-dose method may overestimate the true risks by one order of magnitude, yet in other cases even may underestimate it. The proposed method using organ-specific risk factors may be more suitable for treatment planning.	3
181	Leist R, Micke O, Seegenschmiedt MH, Adamietz IA, Fakhrian K, Muecke R. Radiotherapy for painful shoulder syndrome: a retrospective evaluation.	Prospective nonrandomized	Patients with painful shoulder syndrome were recruited for this retrospective clinical quality assessment from January 2011 to December 2017. Patients were	To evaluate the efficacy of low-dose radiotherapy for painful shoulder syndrome from an	Of 236 recruited patients (150 women, 86 men; mean age 66.3 [range 31-96] years), 180 patients underwent radiotherapy with a linear accelerator and 56 with an orthovoltage device. Fractionation was 12 × 0.5 Gy in 120 patients, 6 × 0.5 Gy in 74,	2

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	Strahlenther Onkol. May 2025;201(5):495-500. doi:10.1007/s00066-024-02302-x		treated with a linear accelerator or an orthovoltage device at individual doses of 0.5-1.0 Gy and total doses of 3.0-6.0 Gy. To assess response, we used the von Pannewitz score with five levels: "worsened," "unaffected," "improved," "significantly improved," and "symptom free." "Good treatment success" was defined as "significantly improved" and "symptom free." Within-group and between-group differences were statistically evaluated.	orthopedic perspective.	and 6 × 1 Gy in 42 patients. Treatments were completed in one series for 223 and in two series at least 6 weeks apart for 13 patients. Of the 236 patients, 163 patients (69.1%) agreed to be re-interviewed at a median of 10.5 (range 4-60) months after radiotherapy completion. Directly after radiotherapy, 30.9% (73 patients) had "good treatment success," which had increased to 55.2% (90 patients) at follow-up.	
182	Heyd R, Tselis N, Ackermann H, Roddiger SJ, Zamboglou N. Radiation therapy for painful heel spurs: results of a prospective randomized study. Strahlenther Onkol. Jan 2007;183(1):3-9. doi:10.1007/s00066-007-1589-1	Prospective randomized	130 patients were randomized into two groups: the low-dose (LD) group (n = 65 heels) received a total dose of 3.0 Gy given in two weekly fractions of 0.5 Gy; in the high-dose (HD) group (n = 65 heels), two weekly fractions of 1.0 Gy were applied over 3 weeks (total dose 6.0 Gy). In 24 sites of the HD group and 17 sites of the LD group, a second RT course was given. The results were assessed using a five-level function score which was documented before RT, at the end of each RT course, and at 6 weeks and 6 months thereafter	To evaluate the efficacy of two different dose-fractionation schedules for radiation therapy (RT) in patients with painful heel spurs.	At 6-month follow-up, RT led to a highly significant reduction of symptoms in both groups. In the HD group, 31 sites were classified as excellent (score: 90-100), 13 as good (score: 70-85), twelve as moderate (score: 45-65), and nine as poor (score: 0-40). In the LD group, 35 sites were classified as excellent, eight as good, ten as moderate, and twelve as poor. The comparison of the difference of the sum score and the single criteria before RT and at 6 months after RT using the Wilcoxon-Mann-Whitney U-test revealed no statistically significant difference of response to RT between both groups.	1
183	Alvarez, B · Montero, A · Hernando, O ... Radiotherapy CT-based contouring atlas for non-malignant skeletal and soft tissue disorders: A practical proposal from Spanish experience. Br J Radiol. 2021; 94 (1124), 20200809. doi: 10.1259/bjr.20200809.	Retrospective	The clinical efficacy of LD-RT is supported by a large body of evidence. However, there is no consensus on the parameters for contouring the planning target volume (PTV). Moreover, 3D simulation and planning should be the standard of care even for nonmalignant disorders. For this reason, the present guidelines were prepared to help guide PTV contouring based on CT images,	To provide a CT-based contouring atlas to help identify and delineate the most common osteoarticular regions susceptible to LD-RT.	PTV for radiotherapy requires precise identification of the target areas based on CT and other imaging techniques. Using a series of cases treated at our institution, we have defined the PTVs for each location on the simulation CT to establish the relationship between the image and the anatomical structures to be treated. We also specify the immobilization systems used to ensure treatment accuracy and reproducibility.	3

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			with the same quality criteria for patient immobilization, treatment simulation, planning and delivery as those routinely applied for cancer radiotherapy.			
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Article Key:

Of the 183 references cited in the American Radium Society® Appropriate Use Criteria for LDRT for Periarticular Disorders, 51 were identified through the search strategy, with 9 additional studies included through backward citation searching, identified by examining the reference lists of articles directly found through the search strategy. 123 additional studies referenced outside the “Summary of Literature Review” are included to provide context, but unless they are also cited within the “Summary of Literature Review” they were not used by the committee to guide recommendations. In sum, the authors added 132 citations from bibliographies, websites, or books not found in the literature search.

Of the 60 references used as evidence, 60 are categorized as therapeutic references including 8 well-designed studies (Phase II randomized and Phase III), 15 moderately well-designed studies that account for most common biases (matched cohort and Phase II studies), 15 studies with design limitations (retrospective reviews), 19 supplemental studies (not useful as primary evidence), and 3 meta-analyses.

ARS Appropriateness Criteria Evidence Table Key:**Study Quality Category Definitions**

Category 1 The study is well-designed and accounts for common biases.

Category 2 The study is moderately well-designed and accounts for most common biases.

Category 3 There are important study design limitations.

Category 4 The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:

- a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
- b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
- c) the study is an expert opinion or consensus document.

Category M The study is a meta-analysis and has not been rated for quality because the method is designed to evaluate individual studies only.

Abbreviations Key:

* Reference found by backward citation searching, identified by examining references cited in articles selected from the search strategy that were published prior to 1/1/2020 and significantly contributed to the literature.